been frequently excited to give shocks, and in whom a small fish found in its stomach after death, appeared to be totally undigested. The secretion of mucus was also either suppressed or considerably diminished. From the circumstance that the branchiæ are supplied with twigs of the electrical nerves, the author conceives there may be some connexion between the electrical and the respiratory functions; and that the evolved electricity may be employed in decomposing water, and in thus supplying the system with air, in situations where the animal has not access to that of the atmosphere. The author considers the mucous system of the torpedo as performing important offices in its economy, in consequence of its connexions with the electrical nerves. Contrary to the statement of Mr. Hunter, he finds that the electrical organs are very scantily supplied with blood-vessels. He concludes by some remarks on the peculiar characters of the electricity of the Torpedo, the purposes it appears to serve, and the varieties exhibited by different individuals, according to the age, the sex, and other circumstances.

The Meetings of the Society were then adjourned over Easter to the third of May.

May 3, 1832.

JOHN BOSTOCK, M.D. Vice President, in the Chair.

The following Report, drawn up by the Rev. William Whewell, M.A. F.R.S., the Rev. George Peacock, M.A. F.R.S., and the Rev. Henry Coddington, M.A. F.R.S., on Mr. Lubbock's Paper, read before the Royal Society Feb. 9, 1832, and entitled, "Researches in Physical Astronomy," was read.

Report.

The method of the variation of parameters as applied to the investigation of the perturbations of the solar system has been successively developed in modern times. This method gives the variations of the elements of the elliptical orbit in terms of the differentials of a certain function R of these elements, and of the disturbing forces. Euler, Lagrange (1783), Lagrange and Laplace (1808) obtained the formulæ for $d\,\alpha$, $d\,e$, $d\,\varpi$, $d\,p$, dq where $p = \tan\varphi \sin\theta$, $q = \tan\varphi\sin\theta$. Poisson first gave the expression for $d\,\varepsilon$. Pontécoulant, p. 330, has introduced $d\,\iota$ and $d\,\nu$ instead of dp and $d\,q$; but those developments gave expressions neglecting the square of the disturbing force. Mr. Lubbock has published (in a Paper in the Phil. Trans. April 1830,) expressions which include the effect of any power of the disturbing force. This method has been principally applied to the secular inequalities; but it is susceptible of being applied with no less strictness to periodical inequalities, all of which may be represented by certain changes in the elements of the elliptical orbit.

But the same problems may also be approximately solved directly; for we obtain a differential equation involving the radius vector and the time. In this equation there occurs the same func-

tion R of which we have already spoken; and this function is expanded according to terms involving cosines of the mean motions of the disturbing and disturbed planet, and cosines of the difference of certain multiples of these motions. This expression has been treated of by various authors, and among others Mr. Lubbock has himself (in memoirs read May 19 and June 9, 1831,) given the expansion of R in a form suited to his present object.

The coefficients of the terms in this expansion are arranged, as usual, according to the order of the excentricities, their powers and products, and to the power of the $\sin^2$ of half the inclination. These coefficients involve also certain quantities $b_{n,i}$ where n and i have a variety of values; and these quantities depend on the ratio of the mean distances of the disturbing and disturbed bodies from the sun.

Solving the differential equation which involves r, by the equating of coefficients, Mr. Lubbock finds a value for the reciprocal of r in such terms as have been mentioned. By certain algebraical transformations of the fractional coefficients in which i occurs, (and by certain equations of condition between $b_{3,i-1}$, $b_{3,i}$, b_{3i+1}, and between similar quantities,) the expression for the reciprocal of r is transformed and reduced, the arcs remaining as they were.

But by the properties of the ellipse, the reciprocal of r is equal to a series of terms involving the excentricities, and involving also cosines of the mean anomaly and its multiples: and hence the variation of this reciprocal is equal to a similar series, involving sines and cosines of such arcs, and involving also the variations of the elliptic elements. By substituting the variations of the elliptic elements given by the formulæ above mentioned, when we put for R its expansion, we have a certain series of sines and cosines with their coefficients multiplied into certain other sines of the same kind.

It is found that the sines and cosines thus multiplied produce, by trigonometrical transformations, arcs identical with those which were found in the value of the reciprocal of r obtained by the former method; and the coefficients are also found to be identical with those resulting from the former transformations and reductions.

We have not thought it necessary to verify the somewhat complex reductions by which Mr. Lubbock has shown the identity of the results obtained by these two methods. The mode of proceeding is perfectly satisfactory, and the truth of the conclusion might have been foreseen. The reductions, however, by which identity was to be exhibited were by no means obvious: and we conceive it not unlikely that the development of them may sometimes be of use in enabling us to judge which of the two methods of solution may be applied with most convenience in particular cases.

We are of opinion that this Paper is well worthy of being printed in our Transactions. (Signed) W. Whewell.
Geo. Peacock.
H. Coddington.